FEBRUARY 7, 1983

CHEMICAL & ENGINEERING

NEWS

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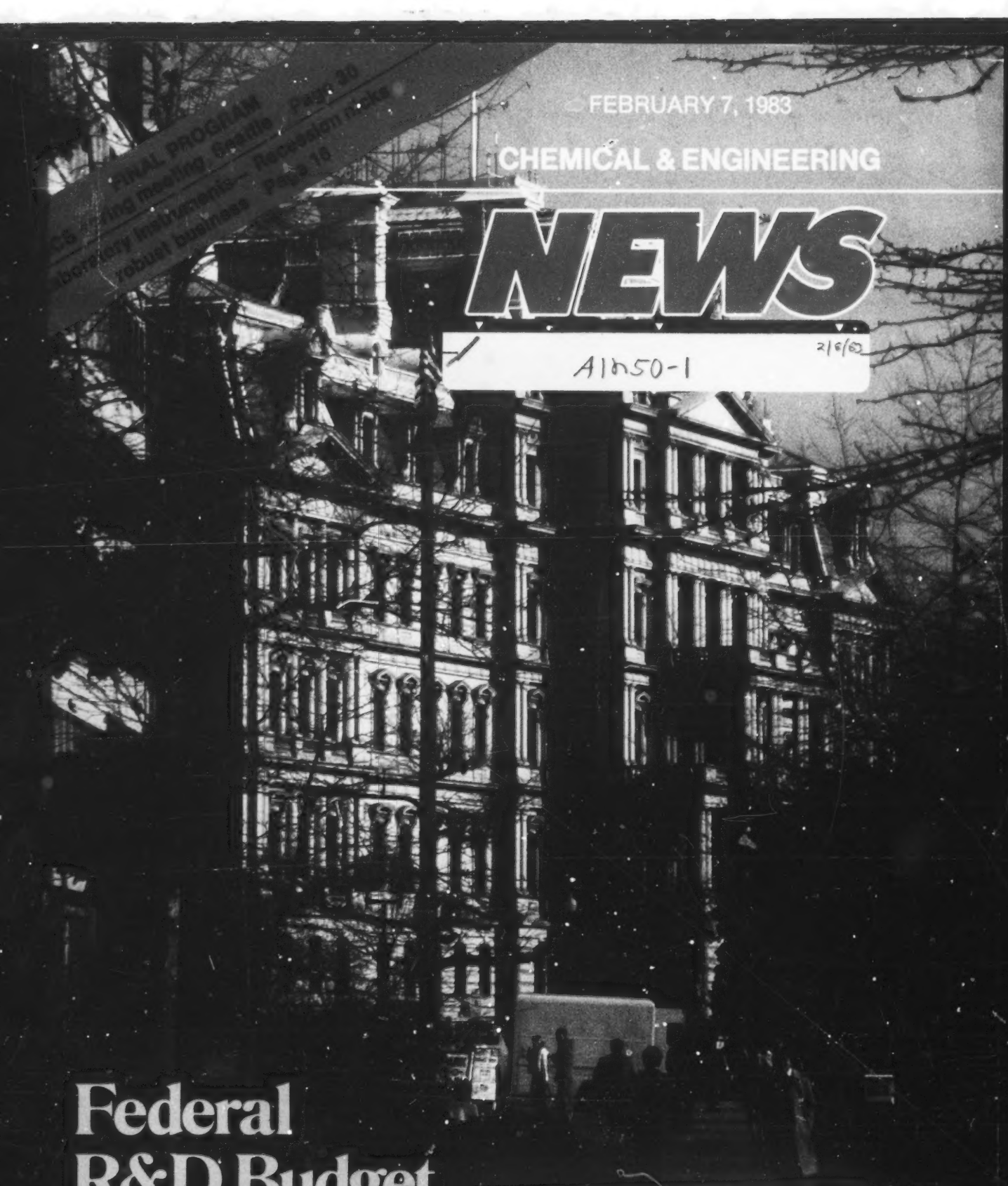

Federal R&D Budget

Despite freeze, some program funds are up, others down Page 9

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Cover: Old Executive Office Building, headquarters of the Office of Management & Budget. Photo by David J. Harrison

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CHEMICAL & ENGINEERING NEWS

February 7, 1983

News of the Week

■ **1983 may be the year the U.S. chemical industry recovers from the recession, if the first two months are any indication.** **Page 6**

■ **Details of the Administration's plan to upgrade science education include additional training for science and math teachers.** **Page 7**

■ **EPA threatens to impose penalties on 31 states for not complying with air cleanup deadlines.** **Page 7**

■ **Einsteinium's heat of vaporization and chemical valence are determined for the first time.** **Page 7**

■ **Reusable ammonia detector has been developed that uses cheap, off-the-shelf components.** **Page 8**

■ **Corporate R&D spending in the U.S. could be hurt if the moratorium on a vexing tax rule is allowed to expire this year.** **Page 8**

Business

Analytical instrument sales remain basically sound in spite of the recession, thanks to large U.S. and export markets. **Page 16**

Government

White House targets science and math education for improvement; proposed program would focus on grants to states. **Page 21**

Science

Tunable source of extreme vacuum ultraviolet radiation has been developed in which laser light is frequency doubled in a crystal, and then frequency tripled by pressurized gas. **Page 28**

Education

Manufacturers contribute to education almost four times as much money as do nonmanufacturers, survey finds. **Page 29**

Final Program

Program for the ACS national meeting in Seattle includes a complete guide to technical sessions, descriptions of tours, and listings of social and special events. **Page 30**

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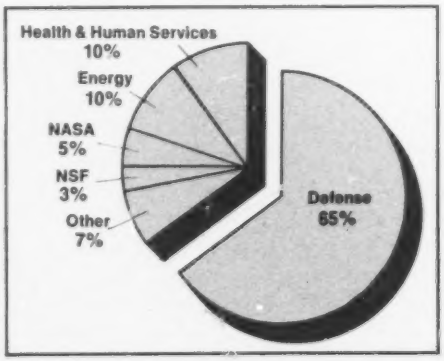


News Focus

1984 federal budget allocates a large share of the R&D pie to defense, but basic research also benefits. **Page 9**

R & D would gain in 1984 federal budget

Almost all of proposed R&D funding increase is defense-related; basic research also would benefit

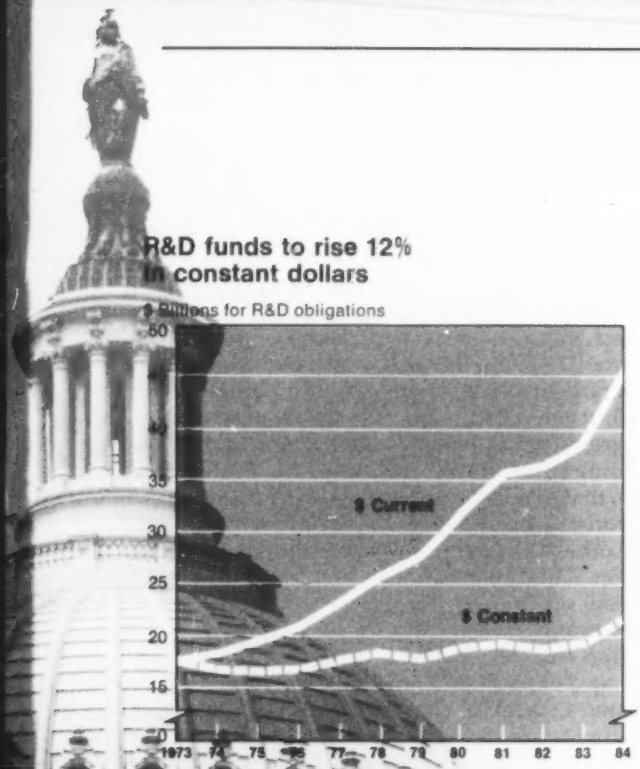
Janice R. Long and David J. Hanson, C&EN Washington

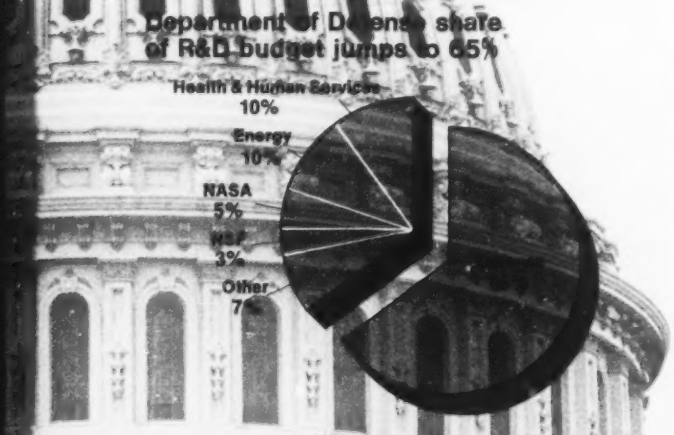
In the light of the overall freeze on domestic spending imposed by President Reagan, the research community may well be pleased with the fiscal 1984 budget proposal sent to Capitol Hill last Monday. In that budget, total obligations—money committed—for R&D would be up 18% to $45.8 billion, whereas outlays—money actually spent—would be up 12% to $42.7 billion. That would result in a two-year (1983–84) growth in federally supported R&D of 26% in obligations and 24% in outlays. The total federal budget, on the other hand, would be up only 5% to $848.5 billion. (Revenues are estimated at $659.7 billion, leaving a deficit of $188.8 billion.) Most of the increase in federal spending would be eaten up by a 10% increase in defense spending, leaving domestic programs level or down.

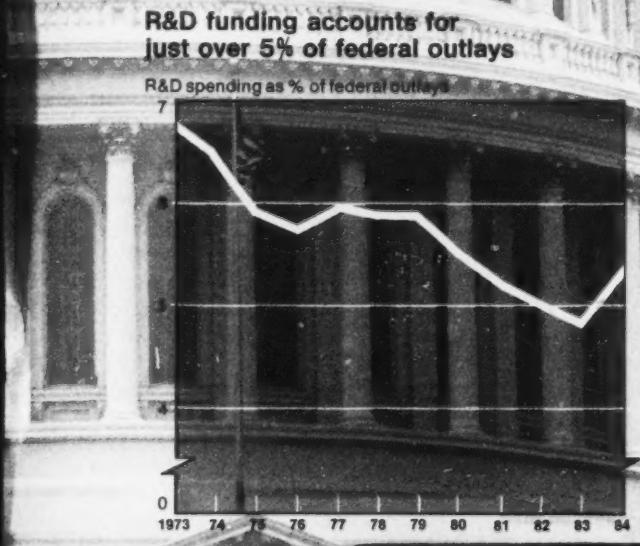
The budget also calls for a 10% increase to $6.6 billion in obligations for basic research, allowing a two-year growth of 22%. Outlays for basic research would be up 8% to $6.4 billion, for a two-year growth of 18%. Funding for R&D facilities, down 1% this fiscal year, would fall another 4.3% to $1.2 billion, and outlays, down 7.6%, this year would fall a further 4% to $1.1 billion.

Before the rejoicing becomes too widespread, a note of caution must be sounded—the increases in R&D obligations are far from uniform. Of the $6.9 billion increase in total R&D obligations, 96.6% would go to defense R&D. In fact, funding for seven of the 13 major federal supporters of R&D, as broken down by the Office of Management & Budget, would actually decrease in fiscal 1984; funding for the Department of Energy would be held essentially constant.

In basic research the increases have been targeted to the physical sciences and engineering, with funding in that area up 15% to $3.9 billion. Thus, funding for basic research would be up 18% at the National Science Foundation, 19% at the Department of Energy, and 13% at the National Aeronautics & Space Administration. In contract basic research, funding for the agencies that support primarily life and social sciences would be up






R&D funding accounts for just over 5% of federal outlays
R&D spending as % of federal outlays
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Glossary of budget terms

Deferral. Any executive branch action or inaction that delays the availability of budget authority for obligations. Deferrals may not extend beyond the end of the fiscal year and may be overturned at any time by either branch of Congress.

Fiscal year. Year running from Oct. 1 to Sept. 30. The fiscal year is designated by the calendar year in which it ends.

Obligations. Commitments made by federal agencies to pay out money for products, services, or other purposes, as distinct from the actual payments.

Outlays. Payments for obligations incurred under budget authority, generally made by issuance of checks by Treasury. Outlays during any fiscal year may be payments incurred in prior fiscal years or in the same fiscal year.

Rescission. Enacted legislation canceling budget authority previously granted by Congress. Rescissions proposed by the President must be approved by Congress within 45 days to become effective.

only 3% to $2.7 billion. For example, funding for basic research at the National Institutes of Health would be up less than 2% to $2.1 billion.

A breakdown of the federal R&D budget by agency shows the Department of Defense standing like a mountain in a field of molehills. It comprises 65% of the total R&D budget for fiscal 1984 and is more than six times larger than its nearest rival, Energy. The 1984 DOD figure of $29 billion represents a 30% increase above fiscal 1983, and a 46% rise from two years ago.

Significant increases have been proposed for all segments of DOD's research, development, testing, and evaluations programs. The largest, $3 billion, would be for strategic weapons projects, which include the Peacekeeper (many remember this as the MX) and Trident II missile systems. For tactical weapons, a $1.5 billion raise is proposed to support further work on the Army's M-1 tank, more reliable jet fighter engines for the Air Force, a new lightweight submarine torpedo for the Navy, and other projects.

Research performed in the technology base category, up 13% from fiscal 1983, would go toward developing very high speed integrated circuits for further miniaturization of microelectronic devices, plus research focusing on information processing, materials research, fault-resistant electronics, and advanced computer languages. Of the entire DOD research budget, just 3%, or about $870 million, is slated for basic research. This is a 13% increase above fiscal 1983.

When Congress gets around to looking for places to cut the budget—and it will—DOD's R&D program will be especially vulnerable. The huge sums requested for development and testing of the large missile systems were a sticking point in last year's budget debates and are sure to be again. Congressional leaders are seeking to cut Defense outlays as much as $30 billion next year to trim the mushrooming federal deficit, and the R&D area is a likely target.

If Congress also trims the Department of Energy's R&D budget request, it won't be because it's too fat. Overall, DOE's budget is slated for just a 6% increase in fiscal 1984 to $11.3 billion. However, its R&D budget would be down 4% to $4.3 billion and when one factors out the $195.3 million or 16% increase set for weapons R&D and testing, the outlook for the civilian R&D programs is bleak—they would be down 11% to $2.9 billion. In fact, things are so bad that the Energy Department is reduced to saying that although it can't continue to fund programs at the level approved by Congress for fiscal 1983, it has slowed the pace of its efforts to transfer programs to the private sector and is asking for more funding in fiscal 1984 than it did in fiscal 1983.

Be that as it may, under the budget proposal, funding for conservation R&D would be down 75%, that for solar and other renewable resources down 60%, and fossil energy R&D down 57%. On the bright side, funding for general science and research, which funds high-energy physics and nuclear physics, would be up 16% to $645.2 million and funding for supporting research and analysis up 24% to $408.5 million. (The rise could be even greater. Congress held a large part of DOE's fiscal 1983 funding to 1982 levels but implicitly gave it permission to move funds around within that total to reflect increases and cuts that the department had wanted to make. If held to 1982 levels in fiscal 1983, the requested increase for supporting research would be 52%.)

Funding for basic energy sciences would be up either 24% or 33% to $350.2 million, depending on which base level is used. Likewise, within that category, funding for chemical sciences would be up either 9% or 21% to $82.5 million.

New initiatives included in DOE's civilian R&D budget request include initiation of a national advanced materials research center at Lawrence Berkeley Laboratory, expansion of the National Synchrotron Light Source at Brookhaven National Laboratory, and a $6 million university instrumentation procurement program to provide large state-of-the-art equipment whose cost exceeds $100,000.

The Department of Health & Human Services may also have to do some belt tightening, though not to the extent that DOE will. The Administration has requested an increase of just 1.5% for fiscal 1984 R&D spending by HHS. This is the second year in a row that the proposed increase has been well below the rate of inflation. Of the nearly $4.2 billion proposed, the National Institutes of Health would get 90%, a slightly larger share than in previous years, indicating that other agencies that fund R&D, such as the Alcohol, Drug Abuse & Mental Health Administration, would get significantly less. Among the individual institutes, most would get a 1% or 2% increase, with the exception of the Environmental Health Services Institute, which is looking at a proposed 2% cut.

Specific research activities emphasized by the Administration for support next year include cancer chemoprevention, prevention of glaucoma, and biological responses to mixtures of drugs. Also mentioned prominently are clinical trials on a vaccine for herpes simplex viruses, on the effects of interferon on multiple sclerosis, on the role of folic acid in fetal neural tube defects, plus the ever-popular efforts to cure or prevent diabetes.

The total federal R&D package

Agency by agency R&D funding breaks down like this

$ Millions	Obligations			Outlays		
	1984[a]	1983[a]	1982[b]	1984[a]	1983[a]	1982[b]
Defense—military functions	$29,882	$23,179	$20,576	$26,844	$21,847	$18,201
Energy	4,713	4,712	4,758	4,911	5,012	4,974
HHS	4,416	4,316	3,935	4,339	4,262	3,978
NASA	2,473	2,506	3,084	2,421	2,386	3,220
NSF	1,240	1,060	975	1,137	1,002	1,014
USDA	849	850	798	848	839	808
Transportation	519	393	309	451	376	349
Interior	329	373	381	348	411	392
Commerce	227	312	290	249	315	285
EPA	208	241	335	250	295	336
Nuclear Regulatory Commission	200	210	221	200	210	209
Veterans Administration	163	165	140	156	157	138
Agency for International Development	161	152	165	152	200	179
Other	418	391	388	433	425	426
TOTAL	$45,798	$38,860	$36,355	$42,739	$37,737	$34,509

a Estimates. b Actual. Source: Office of Management & Budget

Funds for basic research would be up 10% to $6.6 billion

$ Millions	Obligations			Outlays		
	1984[a]	1983[a]	1982[b]	1984[a]	1983[a]	1982[b]
HHS	$2238	$2184	$1953	$2214	$2154	$1962
NSF	1181	998	916	1083	943	954
Energy	1021	861	777	1001	859	774
Defense—military functions	867	769	686	776	746	603
NASA	682	605	538	658	588	537
USDA	381	362	331	380	356	338
Interior	89	88	74	94	89	74
Smithsonian	68	60	55	62	60	47
EPA	17	21	33	22	25	30
Commerce	16	18	17	17	16	16
Veterans Administration	15	15	13	15	15	13
Education	14	16	16	18	22	22
Other	30	29	31	21	30	31
TOTAL	$6619	$5026	$5440	$6361	$5903	$5401

a Estimates. b Actual. Source: Office of Management & Budget

Funds for R&D facilities would be down 4% to $1.2 billion

$ Millions	Obligations			Outlays		
	1984[a]	1983[a]	1982[b]	1984[a]	1983[a]	1982[b]
Energy	$ 501	$ 619	$ 762	$ 532	$ 623	$ 804
Defense—military functions	438	323	290	349	289	232
NASA	156	160	92	129	136	109
HHS	29	60	29	35	31	38
USDA	26	38	30	22	45	30
Other	45	49	30	48	34	40
TOTAL	$1195	$1249	$1233	$1115	$1158	$1253

a Estimates. b Actual. Source: Office of Management & Budget

Among other HHS functions, the occupational health research done by the National Institute for Occupational Safety & Health remains at a steady level, although if the budget request is accepted it will not have received a funding increase in three years. The John C. Fogarty Center for advanced studies in health sciences and related international health activities, on the other hand, has been a consistent big winner with this Administration, with a 9.4% increase proposed for fiscal 1984, giving it an almost 60% rise since 1981.

The National Aeronautics & Space Administration, for years the second largest research and development agency (after Defense) in the federal government, has slipped this year to fourth. Although its total funding is still very high, its entire budget is no longer being labeled R&D. With the successful transfer of the space shuttle to the operational phase, funding for shuttle production, operation, tracking and data acquisition, and other support has been cut from the R&D figure.

Overall, the R&D budget proposed for NASA for 1984 is slightly lower than fiscal 1983, but the Administration wants some projects funded at a higher level than in this fiscal year. Funding for space transportation systems, which used to include most of the shuttle, would still be up and would be used to fund improvements in that vehicle and development of a new, high-energy upper stage for the Centaur rocket.

Space science programs, particularly physics and astronomy, would get the biggest boost for fiscal 1984. Items here include tracking of Voyager 2 as it continues on its way to Uranus for an encounter in 1986. Also funded in the budget are future launches for the space telescope, now planned for 1985, and the Gamma Ray Observatory for basic research in high-energy astrophysics.

Funds are also proposed to continue work on the Galileo mission to Jupiter. This two-stage spacecraft will include an orbiter as well as a probe that will enter Jupiter's upper atmosphere. It is expected to be launched in 1986 and arrive at Jupiter in 1988. A new program to radar map Venus is also proposed to start in fiscal 1984, as is a new Explorer-class program to

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How the agencies fare

NSF budget up 18% to $1.3 billion . . .

$ Millions	1984[a]	1983[a]	1982[b]
Mathematical and physical sciences	$ 364.3	$ 299.7	$272.8
Astronomical, atmospheric, earth, and ocean sciences	334.9	276.1	259.8
Biological, behavioral, and social sciences	223.6	190.2	176.6
Engineering	123.0	100.8	93.3
Antarctic program	102.1	83.2	68.5
Program development and management	66.0	65.3	63.2
Science and engineering education	39.0	30.0	20.9
Scientific, technological, and international affairs	36.8	44.2	40.3
Special foreign currency	2.6	3.1	3.6
TOTAL	**$1292.3**	**$1092.6**	**$999.0**

a Estimates. b Actual. **Note:** Obligations. **Source:** National Science Foundation

. . . with funding for chemistry up 21%

$ Millions	1984[a]	1983[a]	1982[b]	% change 1983–84
Physics	$107.6	$ 88.9	$ 75.3	21%
Physiology; cellular and molecular biology	102.7	85.5	80.1	20
Materials research	99.6	80.8	79.9	23
Atmospheric sciences	90.6	75.0	70.4	21
Ocean sciences	89.1	81.2	75.0	10
Chemistry	80.2	66.2	61.4	21
Astronomical sciences	79.3	63.0	59.1	26
Environmental biology	53.6	45.7	42.0	17
Mathematical sciences	42.2	34.7	30.5	22
Earth sciences	42.1	34.1	29.5	23
Behavioral, neural sciences	37.9	33.8	31.7	12
Computer research	34.7	29.1	25.7	19
Chemical and process engineering	27.1	22.3	20.4	21
Social, economic sciences	23.3	19.8	17.6	18
TOTAL	**$910.0**	**$760.1**	**$669.1**	**20%**

a Estimates. b Actual. **Note:** Obligations. **Source:** National Science Foundation

Energy research at DOE down 11%

$ Millions	1984[a]	1983[a]	1982[b]
Energy supply R&D	**$2036.6**	**$2071.0**	**$2350.8**
Nuclear fission	848.2	815.8	1088.5
Magnetic fusion	467.0	447.1	417.2
Supporting research and technical analysis	408.5	328.3	305.5
Environmental research	210.6	227.2	213.6
All other	102.3	252.6	296.0
Defense R&D and testing	**1,080.1**	**1184.8**	**1088.3[a]**
General science and research	**645.2**	**542.6**	**529.4**
Fossil R&D	**94.0**	**217.6**	**417.7**
Conservation	**101.3**	**410.2**	**447.6**
TOTAL	**$4257.2**	**$4426.2**	**$4833.8**

a Estimates. b Actual. **Note:** Obligations. **Source:** Department of Energy, Office of Management & Budget

All NSF chemical research is up

$ Millions	1984[a]	1983[a]	1982[b]	% change 1983–84
Chemistry	**$ 80.1**	**$ 66.1**	**$ 61.3**	**21%**
Chemical dynamics	15.6	13.1	12.2	19%
Structural chemistry and thermodynamics	15.4	13.2	12.2	17
Chemical physics	12.8	10.9	10.0	17
Chemical instrumentation	9.8	6.3	5.9	55
Synthetic organic, natural products chemistry	9.7	8.1	7.5	20
Synthetic inorganic and organometallic chemistry	8.4	7.2	6.7	17
Chemical analysis	8.4	7.3	6.8	15
Chemical and process engineering	**27.0**	**22.2**	**20.3**	**22**
Chemical, biochemical processes	5.8	4.5	4.1	28.8
Kinetics, catalysis, and reaction engineering	4.5	3.6	3.3	25
Thermodynamics and transport phenomena	4.2	3.5	3.4	20
Particulate, multiphase processes	3.9	3.4	3.1	15
Engineering energetics	3.8	3.3	3.3	15
Minerals and primary materials processing	2.5	2.1	1.7	19
Separation processes	2.3	1.8	1.4	28
Biochemistry	**12.9**	**11.1**	**10.7**	**16**
Marine chemistry	**12.3**	**11.1**	**10.3**	**11**
Solid-state chemistry	**8.0**	**6.5**	**6.0**	**23**
Experimental and theoretical geochemistry	**7.2**	**5.3**	**5.8**	**36**
Atmospheric chemistry	**6.9**	**5.7**	**5.1**	**21**
Polymers	**6.6**	**5.4**	**5.3**	**22**
Mantle geochemistry	**4.0**	**3.1**	**2.2**	**29**
TOTAL	**$165.0**	**$136.5**	**$127.0**	**21%**

a Estimates. b Actual. **Note:** Obligations. **Source:** National Science Foundation

Defense gets another huge increase

$ Millions	1984[a]	1983[a]	1982[b]
Strategic programs	$ 8,978	$ 5,747	$ 4,846
Tactical programs	8,705	7,222	6,750
Technology base	3,555	3,137	2,945
Intelligence and communications	3,474	2,686	2,104
Program management and support	3,236	2,869	2,538
Advanced technology development	1,211	826	750
TOTAL	**$29,159**	**$22,487**	**$19,933**

a Estimate. b Actual. **Note:** Obligations. **Source:** Office of Management & Budget

USDA budget falls for the first time

$ Millions	1984[a]	1983[a]	1982[b]
Agricultural Research Service	$472.4	$468.9	$426.0
Cooperative State Research Service	231.7	245.0	219.0
Forest Service	104.4	110.2	114.4
National Agricultural Library	11.2	10.0	8.7
TOTAL	**$819.7**	**$834.1**	**$768.1**

a Estimate. b Actual. **Note:** Obligations. **Source:** Office of Management & Budget

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NASA shows slight drop in R&D funding

$ Millions	1984[a]	1983[a]	1982[b]
Conduct of R&D	**$1708.3**	**$1718.4**	**$2179.6**
Physics and astronomy	514.6	484.3	333.0
Aeronautical research	300.3	312.7	258.4
Space and terrestrial applications	289.0	397.6	319.0
Planetary exploration	205.4	208.7	198.0
Space transportation systems	183.0	117.0	890.0
Space research and technology	138.0	131.4	117.8
Life sciences	59.0	58.7	51.4
Tracking and data acquisition	22.0	8.0	12.0
Research and program management	**762.0**	**787.0**	**905.0**
R&D facilities	**92.2**	**130.2**	**156.3**
TOTAL	**$2562.5**	**$2665.6**	**$3240.9**

a Estimate. b Actual. **Note:** Obligations. **Source:** Office of Management & Budget

EPA's research effort takes another beating

$ Millions	1984[a]	1983[a]	1982[b]
Air	$ 51.2	$ 59.4	$ 63.1
Hazardous waste	27.4	33.0	29.2
Toxic substances	23.8	27.2	34.1
Energy	23.5	25.0	65.7
Drinking water	20.9	23.3	30.9
Water quality	19.2	30.5	53.5
Interdisciplinary	18.1	7.1	6.6
Program management	8.7	8.7	3.7
Superfund	6.4	6.5	13.8
Pesticides	6.1	6.6	7.1
Radiation	0.2	1.7	2.6
TOTAL	**$205.5**	**$229.0**	**$310.3**

a Estimate. b Actual. **Note:** Obligations. **Source:** Environmental Protection Agency

NIH R&D gain is almost invisible

$ Millions	1984[a]	1983[b]	1982[b]
National Institutes	**$3741.5**	**$3699.7**	**$3423.0**
Cancer	990.3	984.6	987.4
Heart, Lung & Blood	628.2	622.9	559.8
Arthritis, Diabetes & Digestive & Kidney Disease	419.6	412.4	368.2
General Medical Sciences	375.0	369.8	340.0
Neurological & Communicative Disorders & Stroke	301.1	295.8	265.5
Allergy & Infectious Diseases	282.7	275.0	237.4
Child Health & Human Development	257.4	253.7	226.2
Environmental Health Services	167.1	170.4	153.9
Eye	143.6	141.9	130.7
Aging	95.8	94.2	81.8
Dental Research	80.7	79.0	72.1
Research resources	**229.7**	**214.9**	**185.1**
National Institute for Occupational Safety & Health	**52.3**	**49.5**	**53.0**
National Library of Medicine	**52.1**	**49.2**	**46.1**
Office of the Director	**40.0**	**38.9**	**34.8**
Research facilities	**22.8**	**29.1**	**10.5**
John E. Fogarty Center	**15.1**	**13.8**	**9.5**
TOTAL	**$4153.5**	**$4095.1**	**$3762.0**

a Estimate. b Actual. **Note:** Obligations. **Source:** Office of Management & Budget

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conduct research in ultraviolet astronomy. One item not mentioned in the Administration wrapup of NASA-sponsored projects is a permanent, manned space station, an idea for which many believe the time has come, considering the success of the space shuttle.

There is no need for any belt-tightening whatsoever at NSF, and director Edward A. Knapp is excited and pleased by the opportunities offered by a proposed overall budget increase of 18%. This year everything would be up, even science and engineering education, which were all but phased out in the 1983 budget request. Funding would be up $9 million to $39 million. Of that increase, $4 million would be used to raise the stipend and cost-of-education allowance for NSF's 1390 graduate fellows. The stipend would be increased from $6900 to $8100, and the cost-of-education allowance would be increased from $4000 to $4900.

Funding for NSF's research programs would be up more than 18% to $1.2 billion and NSF would use a large part of that $186 million increase to boost average grant sizes. In chemistry, for example, project support would be increased 15.1%, or $8.1 million, to $61.9 million.

NSF is also planning on increasing its support of research instrumentation. Foundationwide, this support would increase 100% over fiscal 1982 levels. The fiscal 1983–84 increase is 60.5% to $180.2 million. Support for research equipment and instrumentation by the directorate of mathematical and physical sciences would be up 53% to $86.3 million. Support for acquisition of equipment in the intermediate cost category (between that normally provided in research awards and that made available through major laboratories and national facilities) would be increased $7.7 million, or 61.1%, to a total of $20.3 million.

Graduate student support also would be expanded in fiscal 1984, with the number of graduate students supported on research projects expected to increase 797 to 10,428; the amount of support provided to them would be up 16.2% to $92.7 million. The number of graduate students supported by grants from the directorate of mathematical and physical sciences would increase 323 to 4332. Their support would increase 20% to $40.3 million.

In the budget proposal it appears that only funding for the directorate for scientific, technological, and international affairs (STIA) would decrease in fiscal 1984, from $44.2 million to $36.8 million. But according to Knapp, that decrease would be only on paper, because an additional $22.1 million would be provided for the programs usually funded by STIA from within NSF's discipline-oriented research programs. Out of STIA's budget would come funds for three or four new industry/university cooperative research centers and six to 10 planning grants for additional centers, as well as a 16.7% increase in the industry/university cooperative research program. It also would provide increased support for new research efforts in risk analysis, an area of growing importance in the regulatory policy area.

Funds from the research programs would provide $5.9 million for support of research conducted under bilateral agreements, plus an additional $2.0 million to initiate a new U.S./India program; up to $3 million for a new

program to encourage independent faculty research at predominantly four-year colleges; $2.5 million for the experimental program to stimulate competitive research to fulfill existing commitments while the program is being phased out; and $500,000 for visiting professorships for women.

In addition, the proposed budget includes approximately $6 million for first-year support for up to 200 Presidential Young Investigators Research Awards. Faculty members who are within seven years of their Ph.D. are eligible for the awards, which will average about $30,000 per year. Matching funds from private sources are required.

The Department of Agriculture was not as fortunate as NSF. USDA maintains its position as one of the largest federal funders of R&D, but, for the first time in recent memory, its total R&D budget would fall. Much of the cut would come from the competitive grants program, with another $4 million cut from forestry research.

The largest program, the Agricultural Research Service, would be effectively frozen at the fiscal 1983 level of about $470 million. According to the Administration, in 1984 increased emphasis will be placed on research on genetic engineering in the plant and animal sciences, human nutrition, and postharvest technologies. A new program of postdoctoral fellowships in ARS labs is also planned.

The reason for so small an increase is mainly that short-term applied research is being reduced because it belongs more appropriately in the private sector, Administration officials say.

At the Cooperative State Research Service, a drop in funding of about 5% would mean fewer competitive grants distributed for research. But at the same time, the Administration would expand the program to start giving grants for research in animal sciences.

The Forest Service's R&D program would be cut about 4%, and would have to continue its work on such areas as genetics, silviculture, wildlife habitats, and forest product production at a reduced rate.

According to a special analysis of the budget by the Office of Management & Budget, obligations for R&D at the Department of Interior would be down $44 million to $329 million in fiscal 1984, with most of the cuts coming in the areas of applied mining and applied geological research. Almost 90% of Interior's 1984 funds would be accounted for by the Geological Survey ($136 million), Fish & Wildlife Service ($89 million), and the Bureau of Mines ($68 million). Although that last figure represents a reduction in funding for the Bureau of Mines, it still would be expected to increase its basic research 22%, particularly in the area of strategic and critical minerals. High priority would be given to long-range, high-risk research in extractive metallurgy technology and development of U.S. source substitutes for imported minerals.

The Department of Commerce's research funding would be cut under the budget proposal, not slightly as is Agriculture's, but severely. Overall, R&D funding would be down 27%, or $86 million, to $227 million. The National Oceanic & Atmospheric Administration's research budget would be cut 30% to $135 million. The decreases, according to budget documents, "are primarily in applied areas, more appropriately supported by the private sector."

The National Bureau of Standards is equally hard hit. Its total budget would be down 24% to $94.2 million. Totally eliminated from the budget request are the Center for Fire Research, which supports most basic and applied university fire research, and the Center for Building Technologies; both do a more-than-decent amount of chemical research. Also eliminated are the programs on automated data processing standards and recycled oil. Proposed cuts include measurement research and standards, 3% to $48.7 million; core measurement research for new technologies, 6% to $12.0 million; engineering measurements and standards, 18% to $18.5 million; and central technical support, 71.7% to $4.5 million. The only program that would gain is technical competence, up 7% to $7.7 million.

Few areas of research have been more controversial in recent years than the programs of the Environmental Protection Agency. The Reagan Administration has steadily slashed away at EPA's research, and Congress has attempted to restore some of the funding. This year, the agency has requested a 6% further cut in R&D, down to $206 million from fiscal 1983. Although not as large a cut as requested in previous years, EPA's R&D budget would still be one third lower than it was two years ago.

According to the Administration, the cuts reflect efficiencies and policy changes in environmental research. Three major concerns are better linkage of research to the agency's regulatory priorities, greater attention to quality assurance to improve the reliability of data used by EPA in making regulatory decisions, and a restructuring of the agency's long-range R&D program.

The biggest reduction would come from cutting development work on control technologies in the areas of air quality, municipal and industrial wastewater treatment, and hazardous spills.

Other large cuts would result from EPA's completion of its Great Lakes water quality program and the elimination of the nonionizing radiation health effects research project.

Some small increases are proposed by the agency for fiscal 1984 R&D. These include a $2.1 million raise for evaluation of air pollutants, especially for updating the ambient air quality standards. Acid rain is another area that would receive increased support over 1983, as are health effects of toxic chemicals, quality assurance work in pesticides and drinking water, and Superfund research.

Although the cuts may not seem severe—indeed, they are not as heavy as in some other R&D agencies—Congress has been in the mood to support environmental research and can be expected to try to raise EPA's research funding budget.

The pattern in the past few years, with the exception of the defense R&D budget, has been for Congress either to accept the Administration's budget proposals for increases in R&D funding, or to beef up funding where large cuts had been proposed. That pattern is likely to hold true this year. □

Analytical Instrument Sales Set To Bounce Back After Recession

Industry remains basically sound and basically American, thanks to big home markets, hefty exports, and continued innovation by U.S. firms

Stephen C. Stinson, C&EN New York

It doesn't look good on the surface. Worldwide sales of laboratory analytical instruments may drop about 1% in 1983 from 1982, and 1982 sales were about level with those in 1981. This performance looks like hard times for an industry with past and predicted future growth rates of 9 to 11% per year in constant dollars.

But 1981 and 1982 didn't do that much damage. Analytical instruments are still a robust and profitable business with potential to soar again after the world's current economic decline. And from the view of U.S. instrument makers, it is a distinctly American business, fueled by large markets in the U.S., hefty exports, and home-grown technological advances.

Exact sales data are hard to come by for many areas of the laboratory analytical instrument field. One source is a study by the laboratory instruments consulting firm Alpert & Sutcliffe of Stamford, Conn. C&EN has revised these data slightly to account for a delayed economic upturn, whose time always seems to lie about nine months in the future.

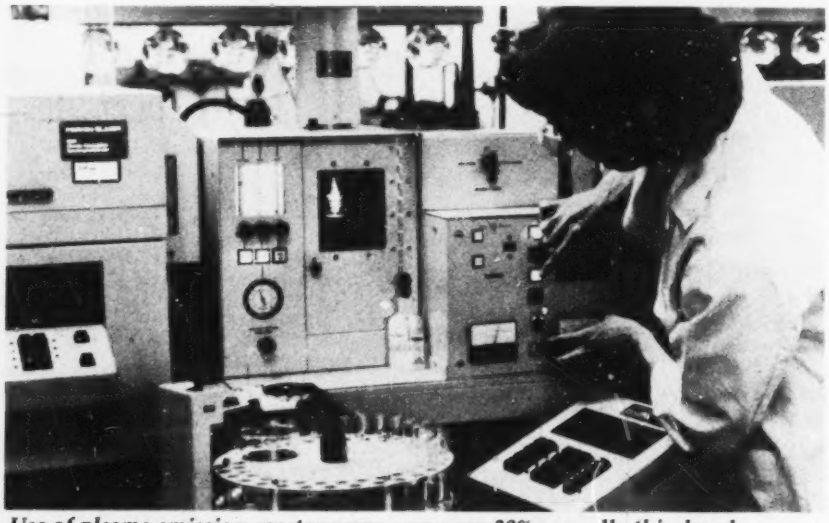
According to these estimates, worldwide sales of laboratory analytical instruments may be a little more than $2.2 billion in 1983, with U.S. customers buying about $1 billion. This U.S. market includes about $185 million in imports. Of the $1.2 billion market outside the U.S., American exports may comprise $800 million.

So instrument foreign trade favors the U.S. decisively. Imports of instruments to the U.S. were growing more than 25% annually in the late 1970s, but exports rose 35% per year, according to data from the Bureau of the Census.

One reason for U.S. leadership in analytical instruments has been its technology. For example, the 15-year trail that led to today's $300 million-per-year market in high-performance liquid chromatography (HPLC) was blazed almost singlehandedly by Waters Associates of Milford, Mass. Also, U.S. instrument makers capitalized on American strength in microprocessors in the mid-1970s to bring on the first generation of "smart" machines. Minicomputers from U.S. technology rendered routine such techniques as mass spectrometry (MS), Fourier transform infrared (FTIR) spectrometry, and nuclear magnetic resonance (FT-NMR) spectrometry. The strategy of U.S. producers in the 1980s is to consolidate their dominance with computer programs to operate instruments, reduce data, and manage lab traffic.

A second reason behind the strong U.S. position in its own markets is the difficulty of establishing adequate service and applications networks in the U.S. Such foreign-controlled firms as Bruker Instruments, Pye Unicam, and Shimadzu Corp. have made important inroads, but their U.S. sales pale beside those of U.S. giants like Hewlett-Packard, Perkin-Elmer, SmithKline Beckman, Varian Associates, and the dozen of more specialized firms here.

Competition for analytical instruments sales in the U.S. has intensified, however, and the major task for U.S. firms in the 1980s is to meet the challenge. As Perkin-Elmer executive vice president Gaynor N. Kelley testified to the House Finance Committee in 1981, "The giants of Japanese technology have identified the analytical instrument business as one targeted for increased market pene-



Use of plasma emission spectroscopy may grow 30% annually this decade because of ease in determining many elements at once

tration worldwide. The survivors in this contest will be those who have successfully married the analytical techniques to the computers that are automating much of the laboratory work up to and including laboratory management.

"It is a very real possibility that we can expect to see our profitability vs. our investment dollar falling as a consequence of Japanese competition—unless we can continue to introduce better instrumentation products through long-term research and development commitments."

In the recent past, that profitability has been considerable. Among the larger, publicly held firms that report results for their analytical instrument businesses, Hewlett-Packard is a case in point. Sales grew at annual rates of 25 to 30% at the end of the 1970s, and operating profits (pretax earnings) at 25 to 30% as well. Operating profits were a highly respectable 15% of sales and 20 to 30% of assets. In the fiscal year ended Oct. 31, 1982, however, sales fell 4% to $177 million, and operating profit declined 10% to $28 million. Still, even in these depressed conditions, operating profit was 16% of sales and 27% of assets.

Perkin-Elmer's instrument group sales rose 20 to 25% per year in the late 1970s, and operating profit increased 10 to 40% annually. Also, operating profit has been 15 to 20% of assets and 12 to 15% of sales. In the 1982 fiscal year (ended July 31), though, sales were down 1.5% to $324 million, and operating profit was down 11% to $44 million. Even so, that profit was 14% of sales and 19% of assets. In the next quarter, sales continued down.

For Varian, the picture is less clear because of a shift of businesses out of the analytical instrument group in 1979. Sales probably grew up to 30% per year at the end of the seventies, but operating profit was only 4 to 10% of sales and 3 to 8% of assets. In fiscal 1982 ended Sept. 30, however, sales were off 10% from fiscal 1981 to $124 million and operating profit was down 10% to $4.5 million.

This overall health of the laboratory instrument business makes acquisitions in this industry attractive. Allied Corp. will acquire Instrumentation Laboratory, Wilmington, Mass. Allied will pay $110 million for the company, half in cash and half in Allied stock as part of a tax-free merger.

Instrumentation Laboratory reported earnings of $4.6 million on sales of $138 million for fiscal 1982 ended March 31, but suffered losses in the next three quarters. Allied chairman Edward L. Hennessy Jr. expects to turn the financial picture at IL around by applying the marketing strength of Fisher Scientific, which Allied acquired in 1981. What attracted Hennessy to IL was the company's line of clinical diagnostic instruments and supplies, which forms 85% of IL's business. IL also has an analytical instruments division, however, which produces such instruments as atomic absorption spectrometers.

Several factors recently have affected sales of laboratory analytical instruments, with some types of instruments affected more than others. Among these factors is a depressed business climate, which has resulted in lower-than-usual increases in research and development budgets in customer industries. Increases in government funding for university research also have been small. In the government itself, there has been a shift away from energy projects but a large increase in defense spending.

A C&EN survey of R&D spending by 15 chemical producers indicates that outlays in 1983 will be up only 5% in 1983, compared with a 13% increase in 1982 and 20% increases for 1981 and 1980 (C&EN, Jan. 17, page 17). The chemical industry is the biggest user of analytical instruments, and its 1983 R&D spending may just balance out effects of inflation.

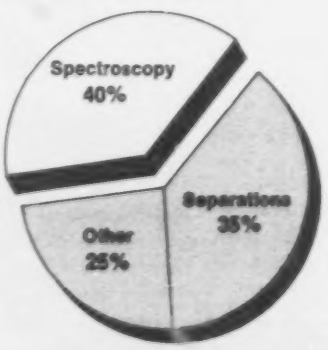
Nelson L. Alpert of Alpert & Sutcliffe says sales of costly research instruments in the $100,000 to $300,000 range may suffer more than those of less expensive systems. Thus mass spectrometry, Fourier transform NMR, and electron microscopy could be especially hard hit. On the other hand, purchases of instruments for quality control laboratories may fare better, because these have obvious and identifiable contributions to productivity, according to Alpert.

Perkin-Elmer president Horace G. McDonnell Jr. pointed out to security analysts last November that "what gets hardest hit are those product lines where operation of the equipment is not destructive to the equipment. Usually, what's hit hardest in recessions is spectroscopy products." Slow but steady wear and tear from heat in gas chromatographs and pressure in liquid chromatographs, for example, result in slightly higher needs to replace chromatographs

Analytical instruments: guidelines for inclusion

In preparing this article, C&EN has adopted the definitions of laboratory market consultants Alpert & Sutcliffe, Stamford, Conn., for analytical instruments. Analytical instruments are instruments that have general or broad use in chemical analysis. These do not include instruments that make mere physical measurements. Thus color analyzers and electronic balances are excluded. Also excluded are instruments too highly dedicated to one use, as in clinical laboratories, and those used to monitor or control processes on-line. Therefore scintillation counters, which are used in research, are included, but gamma counters, used almost entirely in clinical work, are not. Again, instruments for separate quality control testing are included, but detectors that operate as parts of larger, on-line process control systems are not.

Spectroscopy is largest instrument market



Total 1983 global market = $2.24 billion

Sources: Alpert & Sutcliffe; C&EN and industry estimates

than spectrometers, even during hard times.

Analytical instrument makers would reap a bonanza if universities could find a source for the $1.5 billion to $2 billion estimated by the Department of Defense that they need to buy replacements for obsolescent instruments.

A few tens of millions of dollars may be forthcoming from various government agencies in 1983 for this purpose (C&EN, Nov. 8, 1982, page 25). There also have been a few highly publicized research arrangements between universities and industry. But the sum of these efforts falls far short of universities' needs.

Far more promising is the 10% increase in R&D spending to $5.9 billion in 1983 for various government agencies, much of which might be granted to universities (C&EN, Jan. 24, page 7). Increased productivity among instrument and semiconductor producers has kept inflation rates for instruments at about 6% per year, according to Alpert, even in those years when the consumer price index soared. Thus these government grant increases may improve the fortunes of instrument makers somewhat.

For the government itself, some observers have suggested that large increases in defense spending would more than balance the 5% drop in funding to the Department of Energy. DOD accounts for 50% of all government analytical instrument purchases, Alpert notes. Nevertheless, relatively little of defense increases may go for instruments. A more likely source of benefit to instrument makers may be orders from firms that get increased DOD orders for weapons and material.

Among specific types of instruments, high-performance liquid chromatographs may be the largest single best sellers, and their sales are growing at almost the highest rate of any. Worldwide sales of HPLC instruments will be $300 million in 1983, the same as in the two previous years, with about half of these instruments bought in the U.S. Later in the 1980s, HPLC sales may grow at 25% per year in current dollars, largely because of taking some market share away from gas chromatographs.

Reasons for customers' preferring liquid to gas chromatography for separating complex mixtures include the ability to apply LC to four to five times as many compounds as GC, which requires thermally stable volatile compounds; the usual relative lack of need to "clean up" samples for LC; and the fact that the 10,000 theoretical plates for an LC column are sufficient for most separations. But LC suffers from lack of a universal detector, such as flame ionization for GC; use of costly solvents; the greater difficulty of programing reproducible solvent gradients for LC than temperature profiles for GC; and the requirement for some separations of hundreds of thousands of theoretical plates offered by GC columns. Another reason why LC will never drive out GC completely is that GC was there first. Gas chromatographs already are established in laboratories, as are the routine methods for using them where they work.

Gas chromatograph sales and those of supplies and accessories have been a flat $390 million during 1981, 1982, and continuing into 1983. This includes $115 million U.S. sales in each year. Nevertheless, improved columns, sample injectors, and detectors, as well as already successful interfacing of gas chromatographs with spectrometers of various types, point to continuing success for GC, sales of which likely will grow at 20% annually this decade.

By the same token, HPLC will never replace the last atmospheric-pressure liquid column chromatograph. This is because many investigators in the life sciences fear that high pressures of HPLC may degrade their sensitive samples. In addition, column chromatography uses smaller volumes of costly solvents than HPLC. Sales of column chromatographs thus will be a hefty $150 million around the world, and U.S. chemists will take half of that. As world economies resume growth, column chromatograph sales may rise at 12% annually.

But amino acid analyzers may suffer more than GC or column chromatography from HPLC competition. These analyzers are really highly dedicated HPLC instruments, and there is little incentive to buy such specialized equipment when an existing HPLC can be adapted so readily to amino acid analysis. World sales of amino acid analyzers probably will reach $27 million in 1983, including $10 million in the U.S. These sales volumes actually may decline slightly in later years.

Hewlett-Packard has tried to solve the problem of the universal LC detector by adapting its diode-array ultraviolet-visible spectrophotometer to this use. This device samples each LC peak with many rapid bursts of light, diffracts the analyzing beam with a grating toward a string of diode detectors, and records the number of "counts" at any wavelength. If the price can be made affordable, the technique may become the closest approach yet to routine universality.

Some workers see microbore columns as a means to reduce solvent consumption. Microbore columns have the same 25-cm length as conventional ones, but internal diameters are 1 mm rather than 4.6 mm. Microbore columns use 3 μm-particle packing instead of 5 μm- to 10-μm-particles of conventional ones. As a result, microbore columns reduce solvent consumption 95%.

An alternative is to use columns only 3 to 5 cm long, with the usual 4.6-mm internal diameters and 3 μm-particles. In addition to reducing solvent consumption 90%, these short columns reduce analysis time 95% in comparison with microbore or conventional columns and cost about half as much. The number of theoretical plates is only 5000, but that still may be enough for most analyses.

Other advances that would increase the utility of HPLC would be successful interfacing with such instruments as infrared and mass spectrometers, as already has been done for GC. Such techniques give information about molecular structures of components as fast as they are separated in mixtures. In HPLC-MS combinations, the problem is what to do about the large excess of solvent that carries the solute to be analyzed. For HPLC-IR, difficulties arise in scanning such dilute solutions and from interfering infrared absorptions of solvents.

For mass spectrometry, the Hew-

lett-Packard interface vaporizes solvent and solute and admits a minute amount of the vapor to the spectrometer through a 5-μm hole. Solvent vapor serves as reagent gas in the ensuing chemical ionization. The approach of Finnigan MAT is to coat a moving belt or wire with the effluent solution, and evaporate the solvent before the moving zone reaches the spectrometer ion source. The still experimental method of Sciex divison of MDS Health Group (Thornhill, Ont.) is HPLC-MS-MS, which vaporizes the solution, analyzes the vapor in one mass spectrometer following chemical ionization, selects one solute ion, and analyzes that ion in a second mass spectrometer, free of other species.

To solve the problems of HPLC-IR, D. Warren Vidrine, a chemist for Nicolet Instrument, has advocated both use of solvents that do not have interfering infrared absorbances in the region of interest and use of computer-minded subtraction of what interfering absorbances there are (C&EN, Jan. 12, 1981, page 26). Others object that infrared-transparent solvents are not always the best ones for HPLC. Also, subtraction of interfering peak works well with weak absorbances, but not always with strong ones. Chemistry professor Peter R. Griffiths of the University of California, Riverside, prefers to collect effluent solution onto potassium chloride plates, evaporate the solvent, and analyze the solute residue by diffuse reflectance infrared techniques.

Besides gas and liquid chromatography, other important instrument markets include atomic absorption spectroscopy (AAS) and inductively coupled plasma-atomic emission spectroscopy (ICP-AES), and direct-current plasma-AES. World AAS sales were down 10% in 1982 to $117 million, of which $45 million were U.S. sales. Sales are expected to be flat for 1983. Replacement sales, increasing costs of more sophisticated sampling techniques, and inflation could lead to 8% annual current-dollar growth rates in this mature market in the 1980s.

Sales of plasma spectrographs rose 15% in 1982 to $70 million worldwide, with half of that in the U.S. Sales in 1983 likely will remain steady, but these instruments have a potential for 30%-per-year growth rates in the rest of the decade.

The attraction of the relatively newer plasma spectroscopy lies in its ability to analyze for many elements simultaneously or in automatic sequence. In addition, growing unit volume could lower production costs, further attracting buyers. Still, plasma spectroscopy never will completely replace AAS, because plasma spectrographs cost six to 15 times as much as AAS instruments, and because plasma spectrographs are limited largely to liquid samples. Some progress has been made in getting away from the liquid sample limitation as workers develop gaseous hydride techniques to analyze for such elements as arsenic and selenium.

Ultraviolet/visible spectrophotometers are another large, but mature, market. World sales will be about $158 million in 1983, including $60 million in the U.S. These sales could increase 8% yearly in current dollars, after economic recovery, owing to inflation and replacement of older instruments. Growth rates could be larger as a result of Hewlett-Packard's development of a diode-array UV/Vis spectrophotometer, but the price of these instruments is still quite high. □

Analytical instruments recovery will start in 1984

World sales, $ millions	1981	1982	1983	1984	1985
MOLECULAR ANALYSIS					
Ultraviolet/visible	$ 158	$ 160	$ 158	$ 168	$ 181
Dispersive infrared	77	71	71	76	89
Fourier transform-infrared	21	19	19	24	37
Fluorescence	45	46	45	49	54
Raman	7	7	7	7	8
Polarimetry	6	6	6	7	8
Nuclear magnetic resonance	60	55	55	60	72
Electron spin resonance	9	9	9	9	10
Gas chromatography	300	300	300	348	410
High-performance liquid chromatography	300	300	300	361	455
Amino acid analysis	27	27	27	28	29
Column chromatography	168	172	168	184	206
Mass spectrometry	162	150	150	168	207
Densitometry	38	39	38	41	45
Thermal analysis	66	71	71	76	82
ELEMENTAL ANALYSIS					
Atomic absorption	130	117	117	126	149
Arc/spark	71	72	71	75	80
Inductively coupled plasma-atomic emission	61	70	70	80	103
Energy-dispersive x-ray	39	40	39	44	51
Wavelength-dispersive x-ray	71	73	71	78	87
X-ray diffraction	40	41	40	44	50
Electron spectroscopy	31	32	31	34	38
Scanning electron microscopy	85	87	85	95	108
Transmission electron microscopy	32	32	32	33	35
Electron probe	23	23	23	24	25
Organic elemental analysis	44	45	44	48	53
OTHER					
Ion chromatography	18	19	18	22	28
Voltammetry/polarography	22	24	22	28	38
pH- and ion-specific electrodes	81	83	81	88	97
Titration	27	27	27	29	31
Vacuum ultraviolet	7	7	7	8	10
TOTAL	**$2258**	**$2266**	**$2244**	**$2504**	**$2918**

Source: Alpert & Sutcliffe; C&EN and industry estimates